

Development of a Climatology of Vertically Complete Wind Profiles from Doppler Radar Wind Profiler Systems

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Outline

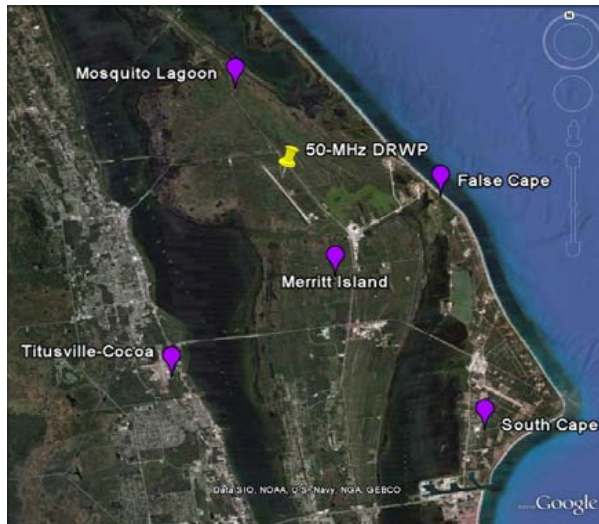
- Introduction
- Doppler Radar Wind Profiler (DRWP) descriptions
- Data quality control (QC) process
- Wind profile splicing technique
- Validation analyses
- Sample size and subsets
- Summary

Introduction

- Impact of winds to space launch vehicle.
 - Design and certification.
 - Day-of-launch (DOL) steering commands.
 - Altitudes where greatest sensitivities exist typically range from roughly 8-14 km.
- NASA has incorporated the use of the 50-MHz DRWP.
 - Discrete profiles and profile combinations (e.g., triplets).
 - DRWP's advantages over balloon-based systems.
 - DRWP archive contains a larger sample size.
 - DRWP archive provides flexibility for assessing trajectory changes due to winds.
 - DRWP profiles mitigate balloon rise time and drift.
 - Issue: Some applications require knowledge of winds and wind changes at low altitudes, and the 50-MHz DRWP does not sample altitudes below 2.7 km.
- This paper describes the method used to generate vertically complete profiles using the 50- and 915-MHz DRWP systems at the United States Air Force Eastern Range (ER).

DRWP Descriptions

- Signal return through Bragg Scatter.
- Winds computed from radial velocities.
- Differences between 50-MHz and 915-MHz DRWP systems.
 - Multiple 915-MHz DRWP systems exist.
 - Different time and altitude ranges and intervals.
 - Different period of record: Concurrent POR 4/2000 through 12/2009
- Archive non-QC'ed data from the ER.



| | KSC 50-MHz | ER 915-MHz |
|-------------------------------|-----------------|-----------------|
| Period of Record | 08/1997-12/2009 | 04/2000-12/2010 |
| Approximate Sampling Rate | 3-5 minutes | 12-15 minutes |
| Approximate Altitude Range | 2,500-18,500 m | 200-6,100 m |
| Approximate Altitude Interval | 145 m | 100 m |



QC Process

50-MHz DRWP

- Automated checks
 - Filled in time gaps with missing data
 - Initial screening of vertical beam
 - DRWP internal shear and meteorological shear
 - Vertical velocity, spectral width
 - “Unrealistic” values
 - First Guess Propagations
 - Small-median test, Isolated datum
 - Rain / convection flags
 - Missing oblique beam signal or noise

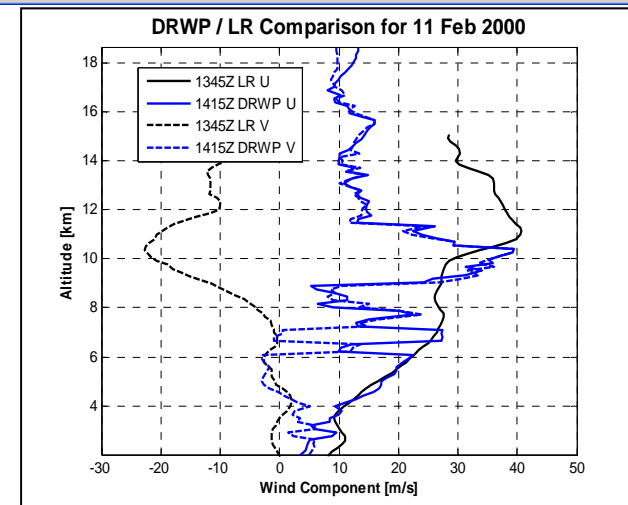
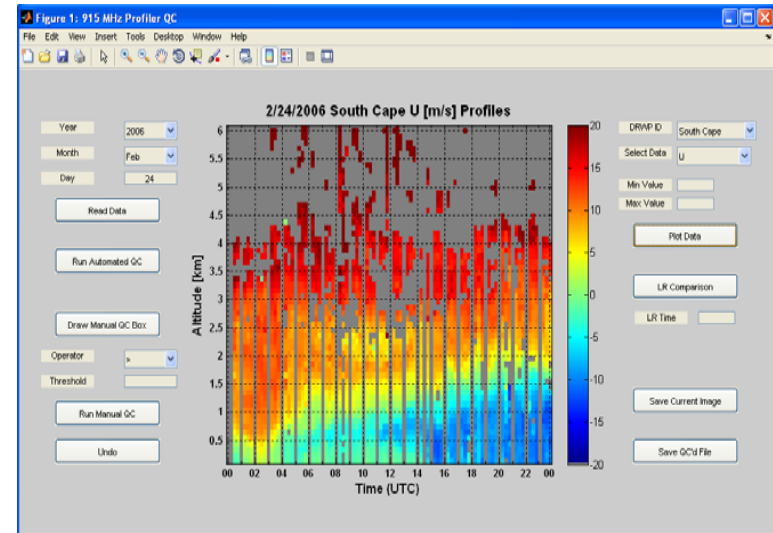
915-MHz DRWP

- Determined validity of generating QC’ed archive.
- Automated checks
 - Filled in time gaps with missing data
 - Number of vertical and oblique beam consensus records
 - “Unrealistic” values
 - Vertical velocity, signal-to-noise ratio
 - Rain / convection flags
 - Meteorological shear
 - Small-median test, Isolated datum

- QC based off literature and data examination.
- Developed analogous manual QC process for each system.
 - Side lobes, ground clutter, convection-contaminated data removal.
 - Removed data based on user-specified thresholds of a variable.

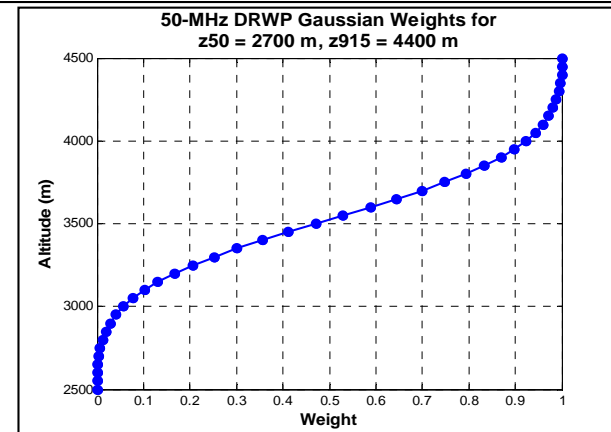
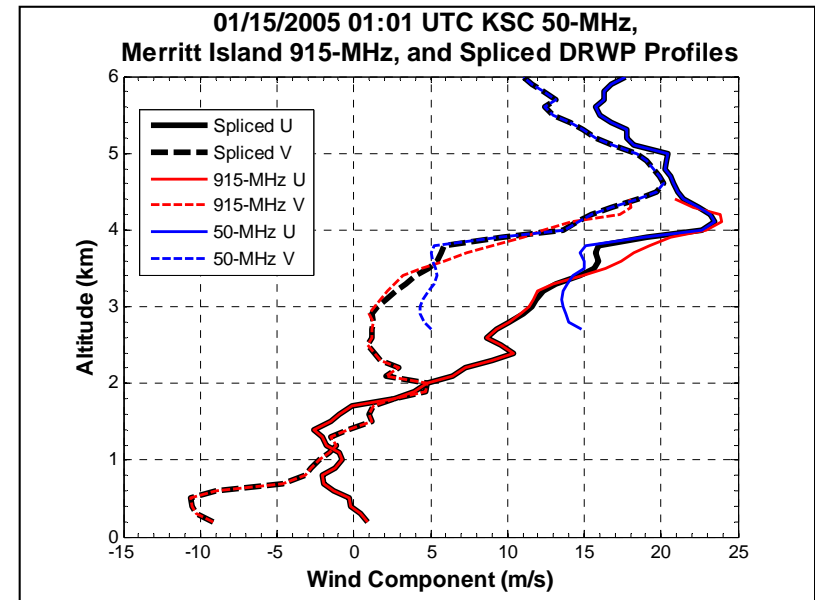
QC Process

- Developed separate Graphical User Interfaces for each system.
- Automated saving of images and logs.
- Enabled comparison with concurrent rawinsonde data.
- Provides means to scrutinize QC process and add data.
- One must QC both archives before splicing profiles.
- Most time-consuming process in database development.



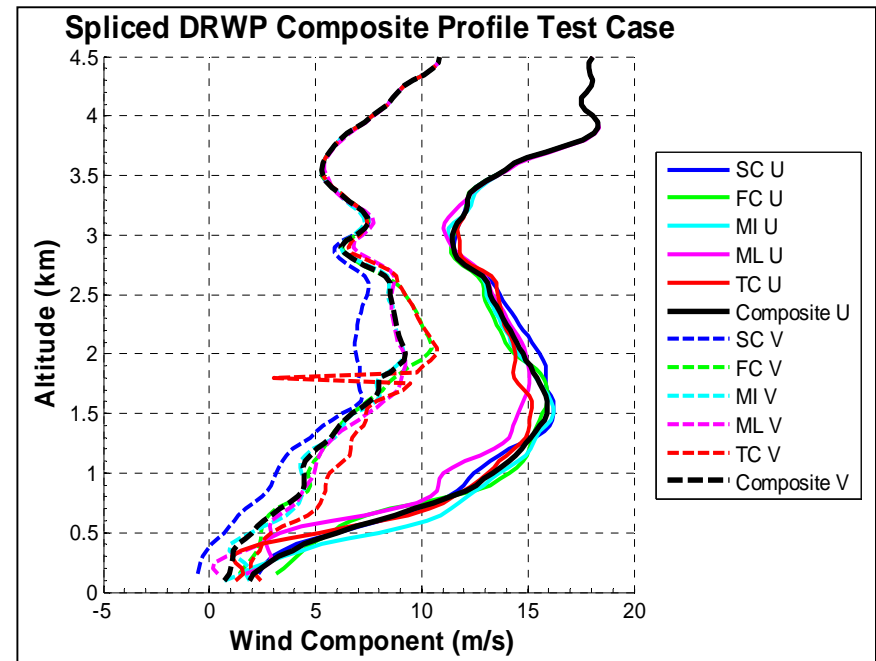
Splicing Technique: Individual Profiles

- Preprocess individual 50- and 915-MHz DRWP input profiles.
 - Interpolate to 50-m intervals.
 - Remove excessively large gaps.
- Do input profiles overlap?
 - Yes: Fair wind components.
 - No: Interpolate wind components.
- Filter spliced profile to 300-m wavelength.
 - Consistent spectral content.
 - 50-MHz DRWP Nyquist wavelength.
- Perform shear checks.



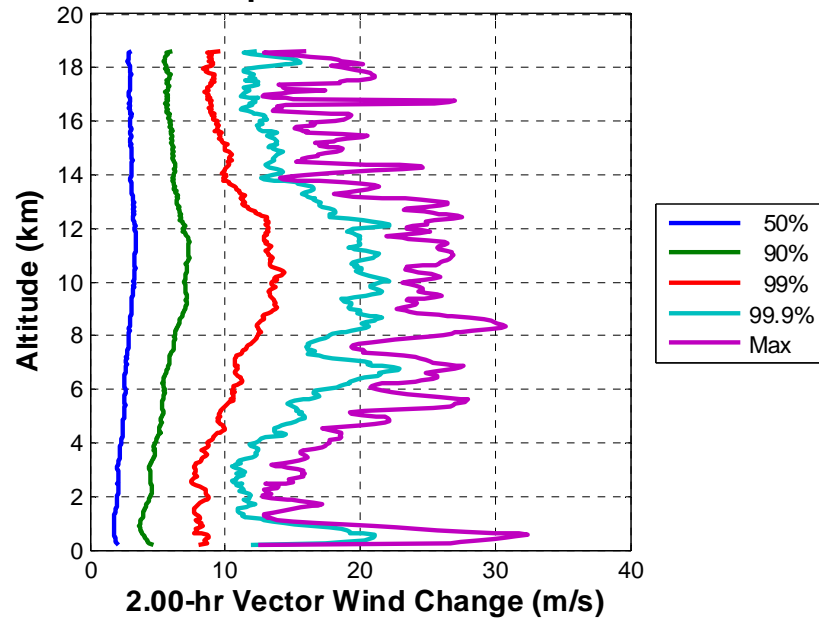
Splicing Technique: Composite Profile

- Up to five profiles can exist at a given time.
- Composite boundary layer (BL) profile.
 - Increase sample size.
 - Allows one to select a single profile to represent the BL.
- Derive consensus average of the five individual spliced profiles.
 - Applied algorithm independently at each altitude.
 - Process favors the 915-MHz DRWPs closest to the 50-MHz DRWP and coast.
- Invoke shear checks and filter.

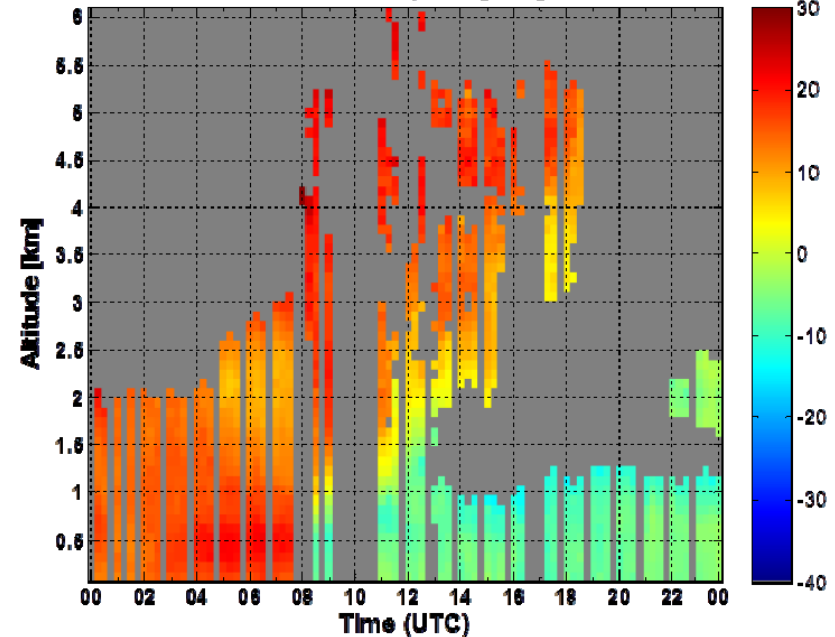


Validation Analyses

Jan Spliced DRWP 2.00-hr Wind Changes
with Composite DRWP BL Profile



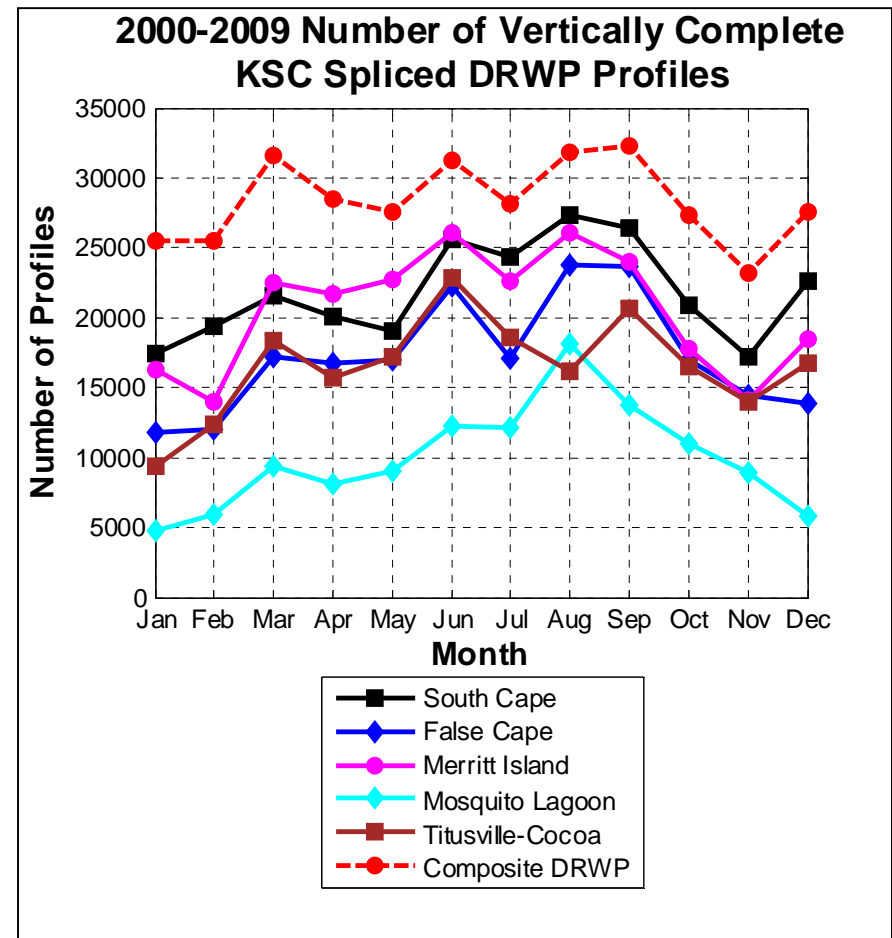
1/18/2006 South Cape V [m/s] Profiles



- Performed analyses as a check to the splicing and QC process.
- Examined wind shear and wind change statistics versus altitude.
- Verified suspect results.
- Re-generated database if analyses produced anomalies.

Sample Size and Subsets

- Roughly 25,000-30,000 complete profiles per month.
- All data at all timestamps are stored for various applications.
- Subsets
 - 4,000 seasonal 1-hr triplets for Space Launch System (SLS) trajectory assessments.
 - 2,000 seasonal 1-hr quintuplets to examine launch window effects.
 - Wind pairs to support NASA's Launch Services Program (LSP).
 - 2,000 seasonal profiles including winds from a local 500-ft tower for ground wind analyses.



Summary and Forward Work

- Developed an archive of vertically complete profiles from the KSC and ER DRWP network for space vehicle design.
- Subsets have been generated to support SLS loads and trajectory assessments and applications of interest to LSP.
 - Different altitude requirements influence sample size.
 - Other subsets can be generated for numerous applications.
- Forward work
 - Incorporate QC and splicing algorithms for use during DOL.
 - Reduced uncertainty in DOL loads and trajectory assessments due to winds.
 - Allow for go / no-go decision making closer to launch.
 - Winds used in DOL assessments will be more representative of vehicle ascent environments.
 - Document process in a peer-reviewed journal.
 - Periodically update archive.

References

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